

SURVIVAL OF TRANSPLANTED CUPRESSUS AND PINUS
AFTER THIRTEEN YEARS IN MENDOCINO
COUNTY, CALIFORNIA

CALVIN McMILLAN

Survival of *Cupressus* seedling trees transplanted to the habitat of the pygmy forest in Mendocino County was reported after seven years (McMillan, 1959). Subsequent observation in 1963 followed a further six-year interval. The survival patterns of *Cupressus* will be discussed with a previously unreported companion study in *Pinus*.

The transplant site, on the coastal plateau between Little and Albion rivers, is within the narrow distribution of *Cupressus pygmaea* (Lemm.) Sarg. and *Pinus bolanderi* Parl. The pygmy forest of the area (McMillan, 1956) represents one of the most unusual vegetational situations in California. Surrounding the pygmy forest and adjacent to the transplant site is the contrasting dense *Sequoia-Pseudotsuga* vegetation.

Seedlings of the various *Cupressus* and *Pinus* strains (table 1) were transplanted from the greenhouse at Berkeley to the pygmy forest in November, 1950. Six seedlings of each strain were planted and covered by two large wire screen-redwood cages. The seedlings remained protected throughout the entire study. *Cupressus* seedlings removed in 1954 reduced the number of seedlings in the transplant plot to 5 per strain. Some *Pinus* seedlings transplanted from the Mendocino County beach were not protected from browsing animals.

The local strain of *Cupressus* showed superior ability to survive in one of the most extreme soil situations (pH 3.8–4.0) in California. Table 1 shows the virtual elimination of all strains except the local one. The only surviving plant originating outside the pygmy forest (from Anchor Bay in southern Mendocino County) had only one remaining green branch in 1963. The strains of *Cupressus goveniana* Gord., *C. abramsiana* Wolf, and *C. sargentii* Jeps. were completely eliminated during the study.

During 1957–1963, height increases were shown by all five trees of the pygmy forest strain. Though considerable by pygmy forest standards, the height increase was only 2–6 cm, averaging 3.7, for this six-year period. All five trees were vigorous and with many side branches and their overall height varied from 19.5–28.5 cm. Only one of the five trees had mature seed cones. The Anchor Bay seedlings, all surviving in 1957, showed little height increase during the 1957–1963 period. The condition of the dead Anchor Bay seedlings, most branches and leaves intact, suggested fairly recent elimination.

Of the eliminated seedlings, those which survived the shortest interval were of a strain of *C. sargentii* from serpentine soils (pH 6.5) in Marin County. The *C. abramsiana* strain was from sandy soils (pH 5.2) near the town of Bonny Doone in the Santa Cruz Mountains. Both of the

C. goveniana strains were from acid soils of the Monterey Peninsula. The strain of *C. goveniana* that survived the longer was from the more acid soil (pH 4.6), a sandy soil on Huckleberry Hill. The other *C. goveniana* strain, eliminated before 1957, was from a ridge between San Jose Creek and Gibson Creek where the yellowish sandy soils (pH 4.9) were derived from granodiorites. The Anchor Bay strain of *C. pygmaea* was from a shallow, yellowish sand (pH 4.8) over sandstone bedrock.

While the reason for the superior fitness of the local strain is not readily apparent, it must include a combination of tolerances that is unique. Although the elimination of the various strains could not be attributed to an obvious biotic factor, some competitive effects of the roots of pines and cypresses surrounding the transplant plot were likely. Since roots are confined to approximately 6–8 inches above the cemented ortstein, it seemed probable that roots extended into the transplant plot with some nutrient interaction. During the 13-year period very little revegetation had occurred on the transplant plot. In 1963, six small seedlings of *P. bolanderi* were on the plot and several leafy branches of *Gaultheria shallon* Pursh were at the margin of the plot. Hundreds of cane-like and cone-bearing trees of *C. pygmaea*, mostly under 100 cm, surrounded the transplant plot, but no cypress germinated on the plot.

Previously unreported was a study of *Pinus* seedlings transplanted in 1950. Included in the series (table 1) were the local pygmy forest strain of *P. bolanderi* (with serotinous cones), the local beach strain of *P. contorta* Loud. (with cones opening at maturity), a beach strain from Oregon, and 2 strains of *P. murrayana* Grev. & Balt. from the Sierra Nevada. In addition, several strains of *P. muricata* Don. were included: the local Mendocino strain from the margin of the pygmy forest, an Anchor Bay strain that grew with *C. pygmaea* in southern Mendocino County, and a strain from Monterey County that grew with *C. goveniana* at Huckleberry Hill.

The pine strains were not as decisively separated in their ability to survive as were the cypresses. One complete elimination was of the beach strain of *P. contorta* from Mendocino County. Four seedlings of the beach strain that were surviving in 1954 showed poor growth and the lone survivor in 1957 had been eliminated by 1963.

Of the surviving members of the *P. contorta* complex, those of the local pygmy forest strain of *P. bolanderi* were taller than the other survivors. Only two seedling trees of the local strain showed a high degree of vigor, one of these having reached a height of 35 cm and the other 19 cm. The remainder were under 11 cm.

When these strains were grown for a year in Berkeley in a control soil, superior vigor was shown by the Oregon beach strain, intermediate vigor by the Mendocino beach strain, and poor growth by the pygmy forest strain (McMillan, 1959). In that study, the Oregon beach strain showed an average height increase during one year of 8.7 cm, the Men-

TABLE I. SURVIVAL OF TRANSPLANTED CUPRESSUS AND PINUS IN THE PYGMY FOREST OF MENDOCINO COUNTY, CALIFORNIA

Strain	Number of surviving seedling trees				
	1950 ¹	1952	1954 ²	1957	1963
<i>C. pygmaea</i>					
Pygmy Forest	6	6	6 (5)	5	5
Anchor Bay	6	6	6 (5)	5	1
<i>C. goveniana</i>					
Huckleberry Hill	6	6	6 (5)	4	0
Point Lobos	6	6	6 (5)	0	0
<i>C. abramsiana</i>					
Bonny Doone	6	6	4	2	0
<i>C. sargentii</i>					
Mt. Tamalpais	6	5	0	0	0
<i>P. bolanderi</i> ³					
Pygmy Forest #1 (ME-20)	6	6	6	4	2
Pygmy Forest #2 (ME-20)	6	6	6	3	3
<i>P. contorta</i>					
Mendocino (ME-101)	6	6	4	1	0
Tillamook Co., Oregon (TL-107)	6	6	6	4	2
<i>P. murrayana</i>					
Sierra Nevada (PA-102)	6	6	4	2	1
Sierra Nevada (PA-103)	6	6	4	2	0
<i>P. muricata</i>					
Mendocino (ME-21)	6	6	6	6	2
Noyo (NO-110)	6	6	6	1	1
Anchor Bay (AB-26)	6	5	4	3	1
Huckleberry Hill, Monterey Co. (HH-28)	6	6	6	5	2

¹ Transplanted from Berkeley greenhouse in Nov., 1950, except *C. sargentii* added April, 1951.
² One seedling of each of the two *C. pygmaea* strains and of each of the two *C. goveniana* strains were removed from the plots in 1954 for documentation.

³ Series #1 planted with cypress seedlings; series #2 planted with pine seedlings.

docino beach strain, 3.3 cm and the pygmy forest strain, 1.5 cm. The alteration of these growth patterns in the pygmy forest habitat suggests the selective significance of unique tolerances of the pygmy forest strain.

In *P. muricata*, decisive superior fitness was not shown by any of the strains (table 1). Some seedlings of each of the strains were able to tolerate the extreme conditions of the transplant site for 13 years, though none was vigorous. The distribution of *P. muricata* at the margin of the pygmy forest, in deeper and less acid soils, suggested an inability to tolerate the pygmy forest soils. Large trees of the local strain occur within 30 feet of the transplant plot, though seedling trees are not present in the immediate vicinity of the plot. Of the five pine seedlings that germinated on the plot during the 13 year study, all were *P. bolanderi*.

In addition to the seedling transplants, young trees of the beach strain of *P. contorta* were transplanted to the pygmy forest habitat. Seven were transplanted with soil around the roots, and seven were transplanted without soil. Soon after transplanting in November, 1950, considerable

damage to the 14 trees was caused by browsing animals. Trees of *P. bolanderi* in the immediate area were not browsed.

After four years, all of those transplanted with soil around the roots were vigorously surviving. At the same time only four of the seven transplanted without soil were surviving and none of these was vigorous. Only two of the seven, bare-root transplants were surviving in 1963. Neither was vigorous, one measuring 8 cm in height and the other 38 cm.

Of the seven transplanted with soil, the recorded heights in 1957 were 70–110 cm, averaging 95 cm. In 1963, they measured 90–140 cm, averaging 107 cm. In spite of the height increase shown by each of the seven plants from 1957 to 1963, one plant had died and three others were with large dead portions at the top of the plants. The three plants with seed cones reacted as plants in the beach population, the cones opening at maturity.

The severity of the pygmy forest habitat has been a selective force that has shaped a unique vegetational cover. This 13-year survival study emphasizes the unique tolerance of the local pygmy forest strain of *Cupressus*. Although it is well known that *C. pygmaea* may become a large tree, the ability to sustain itself in the very acid soils of the pygmy forest is not shared by other strains of cypress. Although the 13-year study had not led to the complete elimination of all other strains of the *P. contorta* complex, the superior growth of the local strain suggests its possible lone success. The survival of the beach strain for 13 years when transplanted with its native soil suggests the restrictive role of the pygmy forest soils. The current lack of vigor of the beach pines suggests the eventual loss of the protective influence of its native soil. The survival of some seedlings of *P. muricata* for the entire 13-year period was least anticipated because of the natural restriction of this species from the most acid soils of the pygmy forest.

Although this study had not been planned as a long-range evaluation of survival, it does suggest the value of projecting such studies. Often short-term soil evaluations suggest broad tolerance ranges by woody plants. This study suggests more critical plotting of populational survival by longer examination.

Department of Botany and Plant Research Institute, University of Texas, Austin

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